CHROMOSOME NUMBERS AND TAXONOMIC NOTES IN THE GENUS *NAMA* (HYDROPHYLLACEAE). II.

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ABSTRACT

Chromosome numbers are reported for 39 taxa of *Nama*. Counts for 25 taxa confirm numbers as previously reported. Counts for 14 taxa are initial reports; 12 taxa conform to the generally diploid pattern found in the genus, while two, *N. dichotomum* vars. *dichotomum* and *pueblense*, are tetraploid with $n=14$. Notes on relationships of selected taxa are included.

INTRODUCTION

Nama houses a diverse assemblage of about 50 species ranging in habit from delicate annuals to robust, woody perennials. Taxa occupy a diversity of habitats, as well, but a majority are confined to the drier regions of the southwestern United States and Mexico. A few species are wide ranging, almost weedy in nature, but most are restricted in distribution. The restriction of several taxa is edaphic and based on the occurrence of gypsum; indeed, some are so faithful to the substrate that they are known as gypsum indicators (Johnston, 1941; Waterfall, 1946). Others, apparently, are even more restricted, causal factors as yet undetermined, and known only from their types or collections near the type locality.

Chromosome numbers have been reported for 25 species and 9 varieties of *Nama* (Bacon, 1974; Cave and Constance, 1947, 1950, 1959; Constance, 1963). Reports portray the genus as remarkably diploid with a base of $x=7$. Only a single species, *N. rothrockii*, departs from the base and only two, *N. lobbii* and *N. jamaicense*, are known to be consistently tetraploid.

In connection with a revisional study of the genus, field collections of the various species, including bud material for chromosome determinations, have been gathered over the past two and one half years. Contained in this communication are original chromosome number determinations for 39 taxa of *Nama*. Included are first reports for 14 taxa, additional counts, from different geographic regions, for previously reported taxa and taxonomic notes bearing upon the status, placement or relationships of various taxa.

MATERIALS AND METHODS

Bud material was field collected into a modified Carnoy's fluid, chloroform:

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95% ethanol: glacial acetic acid (4:3:1 V/V). Material was refrigerated, upon return to the laboratory, until examined. Chromosome numbers were determined from pollen mother cells utilizing the aceto-carmine squash technique (Smith, 1947).

RESULTS AND DISCUSSION

Table 1 presents results for the 88 counts obtained. As can be seen, all taxa are based on $x=7$, except *N. rothrockii*. Counts for previously reported species confirm published numbers. Taxa for which initial counts are reported conform to the strikingly diploid pattern of the genus, with two exceptions; *N. dichotomum* vars. *dichotomum* and *pueblense* are consistently tetraploid. Also, Table 1 contains corrections for two taxa misidentified by Bacon (1974).

Counts for *N. flavescens* are first reports. This taxon is a member of a distinctive group of linear-leaved, perennial species found in the Chihuahuan Desert, the majority of which are obligate gypsophiles. Beguiled by the trend among these species, I have previously implied or stated that *N. flavescens*, too, is an obligate gypsophile (Bacon, 1981). However, collections reported herein, as well as others, were taken from calcareous, gravelly soils or highly fractured limestone beds of roadcuts or mountain slopes. While soils at these localities may harbor some small quantity of gypsum, they certainly are not clearly gypseous as are those in which the obligate gypsophiles, such as *N. stenophyllum* Gray, *N. canescens* and *N. carnosum*, are found. At most, *N. flavescens* appears to be a facultative gypsophile.

The count for *N. pringlei* is the first for this rarely collected species. Hitchcock (1933) reduced this taxon to varietal status under *N. coulteri*. Subsequently, Hitchcock (1939) reassessed his placement and stated that *N. pringlei* could be more consistently recognized as a distinct species. Despite this later re-evaluation, the implication that the two taxa are closely related has persisted. But, it is now clear that they are quite distinct. Indeed, seed features readily separate the two; as examined under the light microscope (x 50) seeds of *N. coulteri* are yellow-orange in color and ovoid-fusiform in shape; those of *N. pringlei* are brown and irregularly oblong. Utilizing ultrastructural features of the seed coat, Chance and Bacon (1984) have identified six species groups within *Nama*. Seeds of *N. coulteri* clearly ally the species with the group to which *N. hispidum* and *N. undulatum*, among others, belong. Seed features of *N. pringlei* are not so readily apparent under the light microscope; however, color, shape and surface patterning suggests it is to be placed within either the group to which *N. dichotomum* belongs or a group in which *N. hirsutum* resides. Seed studies utilizing the scanning electron microscope are underway for these and yet other unexamined species and should resolve the placement of *N. pringlei*. In any event, the relationship between the latter species and *N. coulteri* should be viewed as distant.

TABLE 1. CHROMOSOME NUMBERS IN *NAMA*

(Voucher specimens are or will be deposited at TEX. Counts and collections unless noted otherwise, are those of the author. Numbers between 1716 and 1762 are Bacon and Dillon; those above 1875 are Bacon, Furlow and Barrie.)

N. aretioides (H. & A.) Brand

$n=7$ UNITED STATES: CALIFORNIA: Inyo Co.: Gooddale Creek Recreation Area, *1799*; 7 mi W of Bishop, *1805*; 9 mi W of Bishop, *1806*; Mono Co.: ca 42 mi E of Lee Vining on Hwy 120, *1863*. NEVADA: Washoe Co.: 12 mi N of Sparks, *1808*; 7 mi N of Nixon, *1809*.

N. biflorum Choisy

$n=7$ MÉXICO: NUEVO LEÓN: Salto Cola de Caballo, *1826, 1876*.

N. canescens C. L. Hitchc.

$n=7$ MÉXICO: NUEVO LEÓN: 2 mi E of San Roberto Jct., *1906*; 6.7 mi E of San Roberto Jct., *1489*; 16 mi W of Iturbide, *1897*. Zacatecas: 26 mi S of Zacatecas—Coahuila boundary, *1913*.

N. carnosum (Woot.) C. L. Hitchc.

$n=7$ UNITED STATES: NEW MEXICO: Eddy Co.: 6 mi N of Texas-New Mexico boundary on Hwy 62-280, *1851*. TEXAS: Reeves Co.: 2 mi S of Hwy 752, 19 mi W of Orla, *1850*.

N. coulteri Gray

$n=7$ MÉXICO: SONORA: 5 mi E of Hornos on Hwy 11, *1843*; 25 mi NE of Esperanza, *1844*; 13 mi W of Tónichi on Hwy 16, 1848; 63 mi E of Hwy 15 towards Moctezuma, *1849*.

N. demissum Gray var. *demissum*

$n=7$ UNITED STATES: NEVADA: Clark Co.: 10 mi E of jct Hwy 40 and IH 15, *1764*; vicinity of Mountain Springs, *1795, 1858*.

N. demissum Gray var. *deserti* Brand*

$n=7$ UNITED STATES: CALIFORNIA: Inyo Co.: 11 mi S of Big Pine, *1802*; 4 mi E of Big Pine, *1803*.

N. densum Lemm.

$n=7$ UNITED STATES: CALIFORNIA: Mono Co.: 7 mi W of Benton on Hwy 120, *1807*, *1864*; 22 mi W of Benton, *1862*; 45 mi W of Benton, *1861*; near High Altitude Research Station in White Mountains, *1814*.

N. depressum Lemm ex Gray

$n=7$ UNITED STATES: CALIFORNIA: Inyo Co.: Gooddale Creek Recreation Area, *1800*.

N. dichotomum (R. & P.) Choisy var. *chasmogamum* Brand*

$n=7$ MÉXICO: OAXACA: 4 mi S of Sola de Vega, *2077*. Veracruz: 2 mi above Acultzingo on Hwy 150, *2081*.

N. dichotomum (R. & P.) Choisy var. *dichotomum**

$n=14$ MÉXICO: MÉXICO: 0.2 mi N of Dongue on Hwy 55, *1833*. UNITED STATES: ARIZONA: Coconino Co.: Coconino Natl. Forest, *1702*; 13 mi N of Flagstaff on Hwy 89, *1703*.

N. dichotomum (R. & P.) Choisy var. *pueblense* (Robins. & Greenm.) Macbride*

$n=14$ MÉXICO: PUEBLA: 38 mi N of Tehuacán on Hwy 150, *2057*. OAXACA: ruins at Mitla, *1835*, *2079*; near Teposcolula, *2065*. VERACRUZ: 2 mi above Acultzingo, *2082*.

N. flavescens Brandeg.*

$n=7$ MÉXICO: ZACATECAS: 0.4 mi S of Zacatecas-Coahuila boundary on

TABLE 1. CHROMOSOME NUMBERS IN *NAMA* (CONTINUED)

Hwy 54, *1911*; 11 mi E of Cedros, *1914*.

N. hirsutum Mart. & Gal.*
n=7 MÉXICO: OAXACA: 10 mi NE of jct Hwy 175 and 190, *1836*.

N. hispidum Gray var. *mentzelii* Brand
n=7 UNITED STATES: NEW MEXICO: Doña Ana Co.: 25 mi W of Las Cruces on IH 10, *1762*; 27 mi S of Deming on Hwy 11, *1763*.

N. hispidum Gray var. *sonorae* C. L. Hitchc.
n=7 MÉXICO: SONORA: 5 mi E of Esperanza on Hwy 11, *1843a*; 25 mi NE of Esperanza, *1844a*; 8 mi N of Rosario, *1845*; 4 mi N of Nuri, *1846*.

N. hitchcockii Bacon
n=7 MÉXICO: NUEVO LEÓN: 2 mi N of Hwy 58 on road to Galeana, *1827* (and as *N. johnstonii* C. L. Hitchc. in Bacon, 1974).

N. jamaicense L.
n=14 MÉXICO: SONORA: 5 mi E of Esperanza on Hwy 11, *1842a*. VERACRUZ: 7 mi N of Orizaba, *1755*.

N. lobbii Gray
n=14 UNITED STATES: CALIFORNIA: Siskiyou Co.: 17 mi S of McCloud, *1818*.

N. origanifolium H.B.K. var. *origanifolium**
n=7 MÉXICO: DURANGO: 16 mi W of Durango on Hwy 40, *1840*. HIDALGO: 7 mi NE of Ixmiquilpan, *1716*.

N. palmeri Gray ex Hemsl. var. *palmeri*
n=7 MÉXICO: NUEVO LEÓN: 22 mi W of Linares on Hwy 58, *1891*; 1.5 mi N of Pablillo on Hwy 58, *1828*. SAN LUIS POTOSI: 3 mi E of Hwy 57 on road to Guadalcazar, *1830*.

N. parviflorum (Greenm.) Const.
n=7 UNITED STATES: NEVADA: Washoe Co.: 7 mi N of Nixon, *1810*. OREGON: Lake Co.: 64 mi NE of Lakeview on Hwy 395, *1865*.

N. parvifolium (Torr.) Greenm.*
n=7 MÉXICO: TAMAULIPAS: 34 mi N of Soto la Marina on Hwy 180, *2088*.

N. pringlei Robins. & Greenm.*
n=7 MÉXICO: PUEBLA: 25 mi SW of Tehuacán on Hwy 125, *2061*.

N. propinquum Morton & C. L. Hitchc.*
n=7 MÉXICO: COAHUILA: 86 mi N of Múzquiz on Hwy 93, *1819*, *1819a*.

N. prostratum Brand*
n=7 MÉXICO: JALISCO: E side of Nevado de Colima, *1979*.

N. pusillum Lemm. ex Gray
n=7 UNITED STATES: CALIFORNIA: Inyo Co.: 11 mi S of Big Pine, *1801*. NEVADA: Clark Co.: 33 mi NE of Tecopah, *1859*.

N. retrorsum J. T. Howell*
n=7 UNITED STATES: NEW MEXICO: Sandoval Co.: 9.3 mi E of San Ysidro on Hwy 44, *1695*.

N. rothrockii Gray
n=17 UNITED STATES: CALIFORNIA: Inyo Co.: 10 mi W of Lone Pine on Whitney Portal road, *1812*; Onion Valley, *1813*.

N. rotundifolium (Gray) Macbr.*
n=7 MÉXICO: COAHUILA: 4 mi E of Sacramento, *Hartman & Funk 3967*.

TABLE 1. CHROMOSOME NUMBERS IN *NAMA* (CONTINUED)

N. sandwicense Gray
n=7 UNITED STATES: HAWAII: Oahu: near Waimanalo Beach Park, *Eggleston s.n.* (counts from plants grown from seeds of this collection).
N. sericeum Willd. ex. Roem. & Schult.
n=7 MÉXICO: HIDALGO: 14 mi N of Zimapán on Hwy 85, *1724*; 4 mi N of Mezquititlán, *1758*; 19 mi SW of Jacala on Hwy 85, *1832*. TAMAULIPAS: 18 mi N of Jaumave on Hwy 101, *1837*.
N. serpylloides Gray ex Hemsl. var. *confertum* I. M. Johnst.*
n=7 MÉXICO: COAHUILA: 4 mi S of Cuatro Ciénegas on Hwy 30, *1824*.
N. serpylloides Gray ex Hemsl. var. *velutinum* C. L. Hitchc.
n=7 MÉXICO: COAHUILA: near Hermanas, *Hartman & Sanderson 35416, 1820*.
N. stevensii C. L. Hitchc. var. *gypsicola* (I. M. Johnst.) Bacon
n=7 MÉXICO: NUEVO LEÓN: 16 mi W of Iturbide on Hwy 58, *1896*; 2 mi E of San Roberto Jct., *1905*. ZACATECAS: 26 mi S of Coahuila-Zacatecas boundary on Hwy 54, *1912*.
N. stevensii C. L. Hitchc. var. *stevensii*
n=7 UNITED STATES: NEW MEXICO: Eddy Co.: 6 mi N of Texas-New Mexico boundary on Hwy 62, *1851*. OKLAHOMA: Beckham Co.: 12 mi S of Erick on Hwy 30, *1871*. Jackson Co.: 21 mi SW of Altus on Hwy 6, *1872*.
N. turneri Bacon
n=7 MÉXICO: NUEVO LEÓN: 2 mi N of Pablillo, *1899* (and as *N. origanifolium* var. *origanifolium* in Bacon, 1974).
N. undulatum H. B. K. var. *undulatum*
n=7 SOUTH AMERICA: ARGENTINA: Mendoza: below Cruz del Paramillo, *Richardson 2020*.
N. xylopodum (Woot. & Standl.) C. L. Hitchc.*
n=7 UNITED STATES: NEW MEXICO: Eddy Co.: Sitting Bull Falls, *1853*. TEXAS: Culberson Co.: Pine Canyon, *Sikes & Smith 533*.
*Taxon not previously reported.

Presently, *N. dichotomum* is structured of five varieties, vars. *dichotomum*, *chasmogamum*, *latisepalum* (Loes.) C. L. Hitchc., *pueblense* and *amplifolium* C. L. Hitchc., the latter South American (Hitchcock, 1933). Aside from the fact that these taxa generally exhibit relatively small, white corollas and brown seeds with prominent depressions, I can find little to support their close alliance. Indeed, field observations suggest that the North American taxa should be recognized as species. I have witnessed these taxa in various sympatric combinations in México. Careful searching of these mixed populations has revealed no evidence suggestive of hybridization. B. L. Turner (pers. comm.) confirms these observations for sympatric populations of vars. *dichotomum* and *pueblense* in the state of Veracruz, México. Moreover, numerous herbarium sheets, on loan from ENCB, GH, LL, MEXU, MICH, MO, NY, TEX, UC and US, consist of various mixed collections of these taxa. In all cases, the taxa are clearly distinct. Nature's test for species status

appears to be met among these taxa. Chromosome numbers, initially reported herein, clearly differentiate the var. *chasmogamum* from the vars. *dichotomum* and *pueblense*. Indeed, the var. *chasmogamum* differs from all members of the group in possessing corollas about 10 mm long as compared to about 6 mm for the others. Moreover, this taxon, judging from label data, apparently comprises two corolla color morphs, a blue morph and a white morph. Included counts for this variety are both from populations with blue corollas. This form exhibits tubular-weakly salverform corollas, while those of the white form, which I have yet to encounter in the field, are broader and more campanulate. Habitally, the two forms are quite similar. Possibly, the var. *chasmogamum* houses two entities. Additionally, I am of the opinion that the var. *latisepalum* is misplaced in the *dichotomum* group. In habit, leaf and sepal characters, the variety is much more reminiscent of *N. hirsutum* than of any taxon in the *dichotomum* assemblage. Seed features of the variety, under the light microscope (x 50), also are more reminiscent of *N. hirsutum* than of yet other varieties with which it is presently aligned. Ultrastructural studies of seeds of these taxa are underway. While I feel that the North American taxa of *N. dichotomum* should be treated as species, a formal change is required to elevate the var. *chasmogamum*. Therefore, I retain them here as varieties, pending further supporting evidence, so as not to add, even potentially, to the already lengthy synonymy of *Nama*.

With this report, chromosome numbers are available for 44 taxa of *Nama*. Only five are consistently polyploid. Additionally, two species are reported as both diploid and tetraploid, but the latter ploidy level is represented by single reports against several at the diploid level. Included among the consistently polyploid taxa is the chromosomally anomalous *N. rothrockii* as well as *N. lobii*. The inclusion of these species in *Nama* has been questioned on the basis of morphology and cytology (Bacon, 1974, Raven and Axelrod, 1978) and seed coat structure (Chance and Bacon, 1984). Moreover, flavonoid chemistry of the two is unique among examined names (Bacon, in prep.). Available data countenance the position that these taxa should be viewed as elements phyletically distinct from *Nama*. Nevertheless, adopting a conservative view, accepting *Nama* as presently structured and including as polyploid any taxon for which a polyploid count is reported, the percentage of polyploidy in the genus is slightly less than 16%. This percentage is very low as compared to general estimates of polyploidy in dicots (e.g. Grant, 1963) and somewhat less than that reported in other "cytologically conservative" groups, such as *Penstemon* (Freeman, 1983). It seems likely that *Nama*, as implied by Bacon (1974), will be noted as an example of a diverse group in which speciation has occurred predominantly at the diploid level.

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